FIG. 1

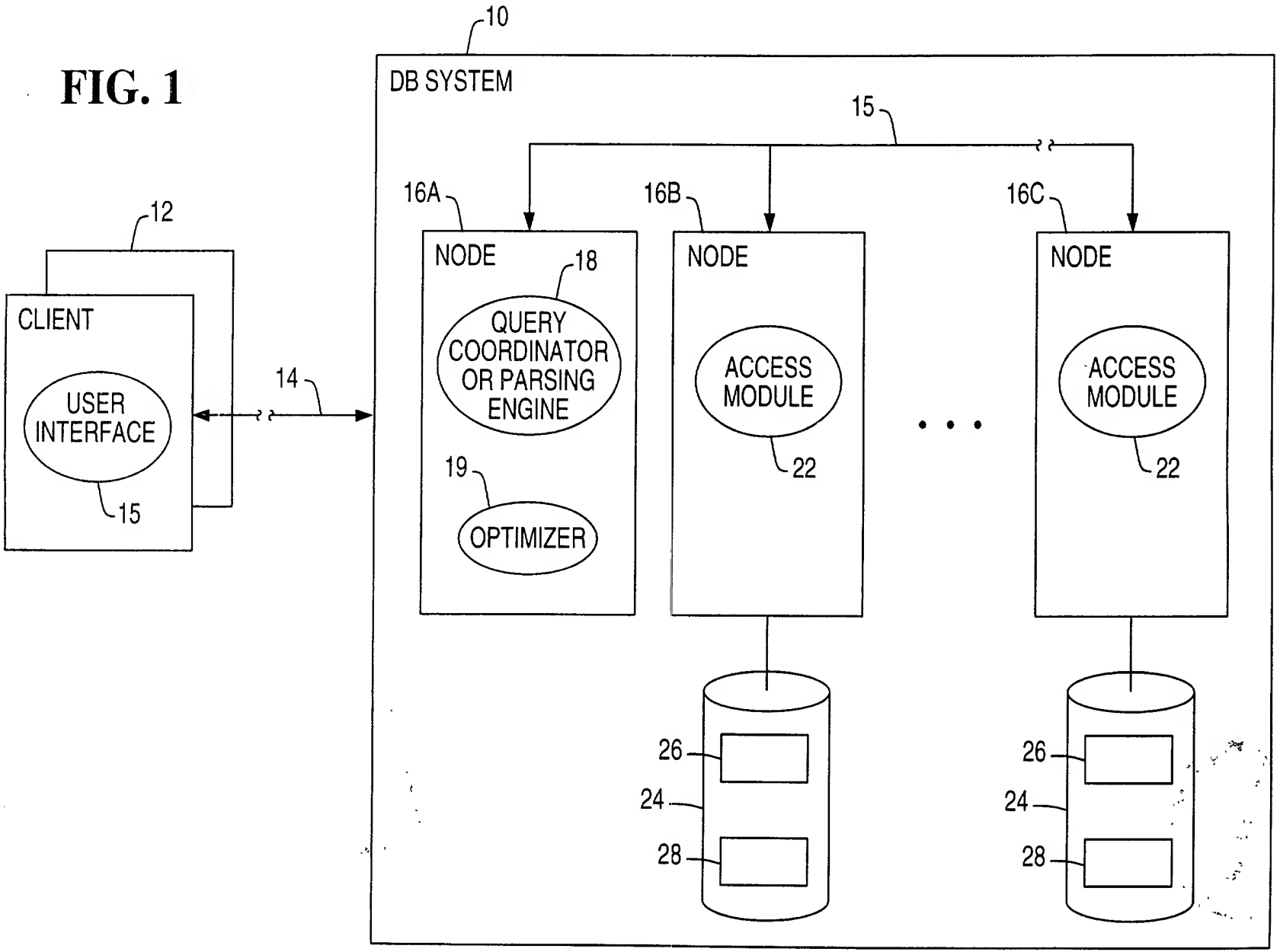

10
DB SYSTEM
15
16A
16B
16C
12
NODE
18
NODE
NODE
CLIENT
QUERY COORDINATOR OR PARSING ENGINE
ACCESS MODULE
ACCESS MODULE
14
USER INTERFACE
22
22
19
OPTIMIZER
15
26
24
28
26
24
28

FIG. 2

Select T1.A, T2.B From T1, T2, T3
Where T1.C=99 AND T2.D='george' AND T3.E=66
AND T1.F =T2.F AND T2.G=T3.G

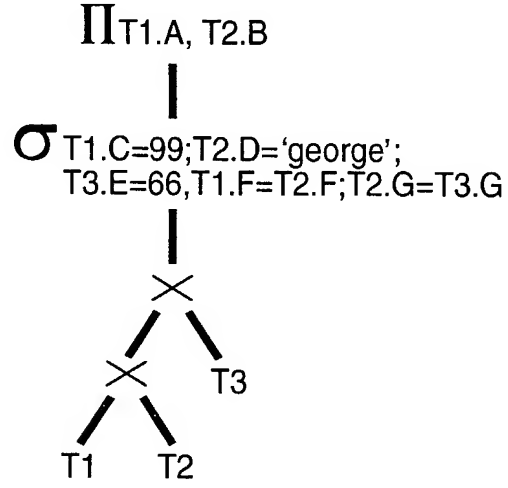


FIG. 3

Select T1.A, T2.B From T1, T2, T3
Where T1.C=99 AND T2.D='george' AND T3.E=66
AND T1.F =T2.F AND T2.G=T3.G

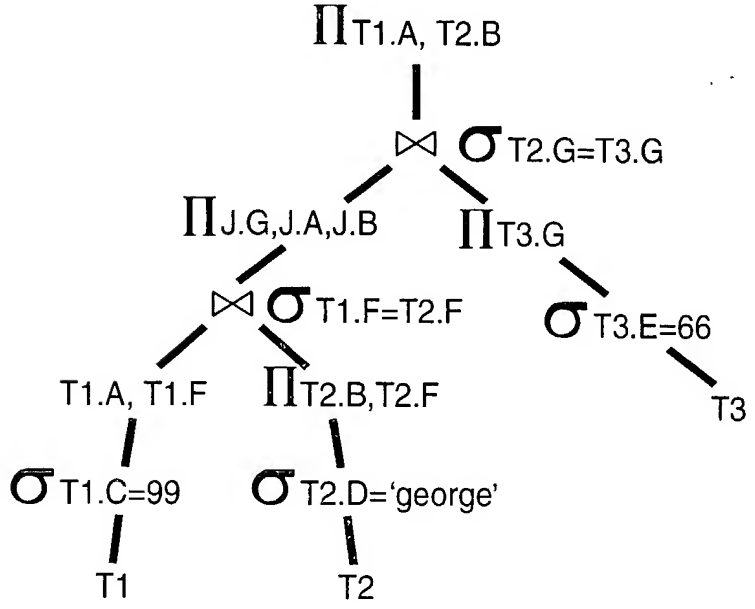


FIG. 4

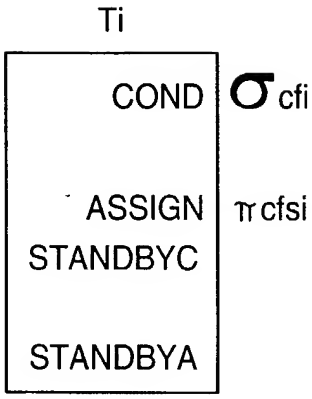


FIG. 9

```
Select T1.A, T2.B, T3.Video Colorize() From T1, T2, T3, T4
    Where T1.face = IMAGE(\\url\myface.jpg) AND T2.D='george'
        AND T4.Audio = AUDIO (\\url\georgeharrison.wav)
            AND T1.F=T2.F AND T2.G=T3.G AND T1.H=T4.H
                AND T2.K=T4.K
```

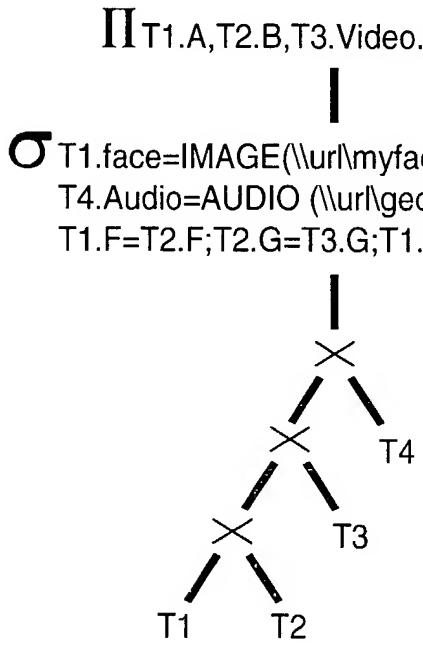
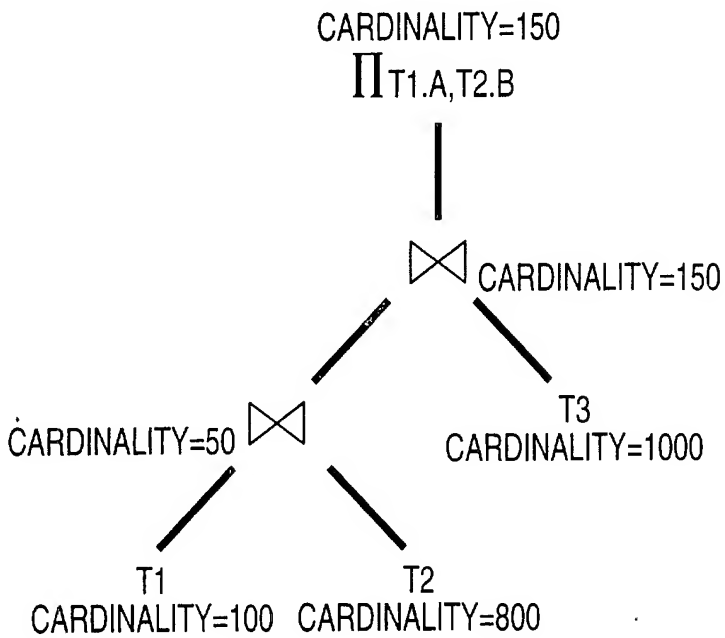


FIG. 5


CARDINALITY=150
Π T1.A,T2.B
CARDINALITY=150
CARDINALITY=50
T3
CARDINALITY=1000
T1
CARDINALITY=100
T2
CARDINALITY=800

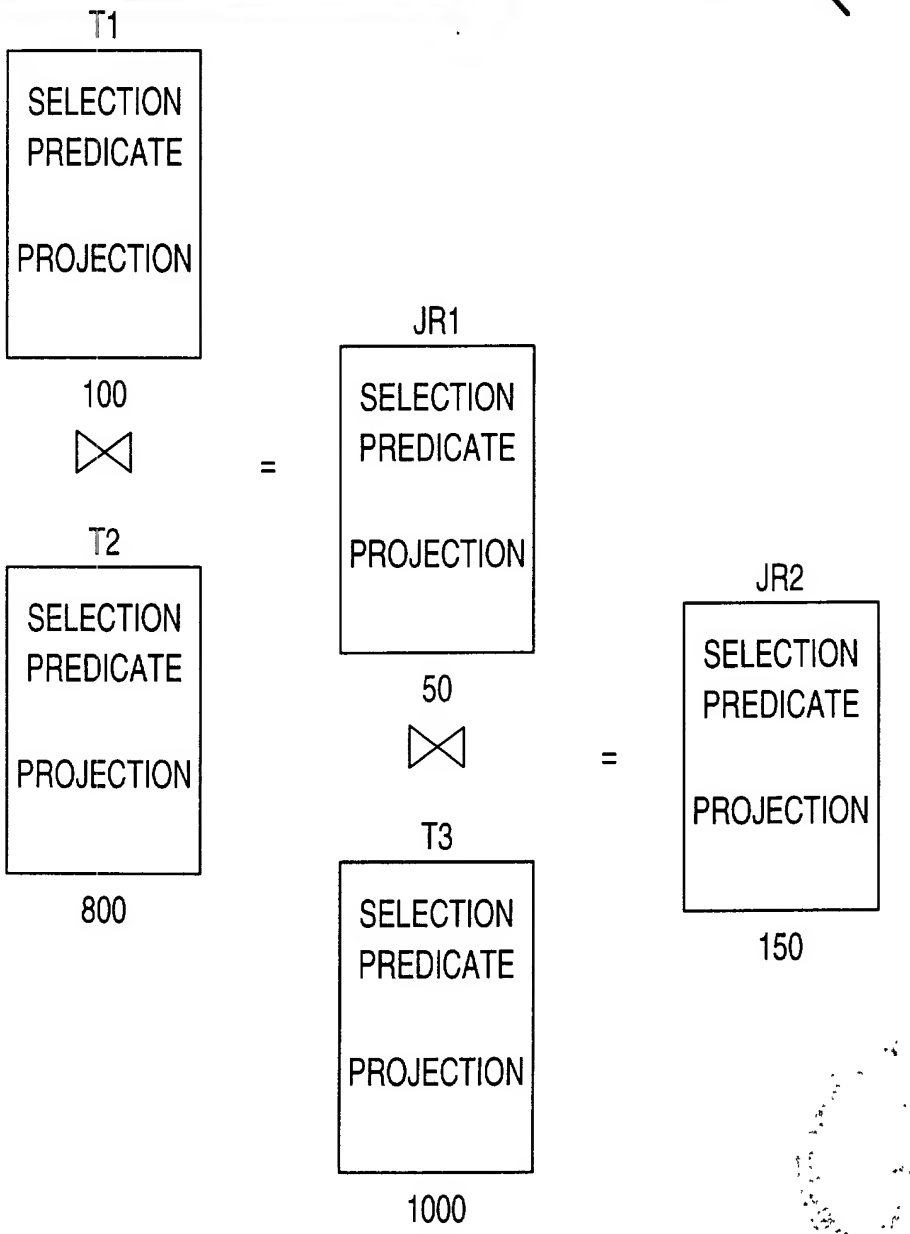

T1
SELECTION PREDICATE
PROJECTION
100
T2
SELECTION PREDICATE
PROJECTION
800
=
JR1
SELECTION PREDICATE
PROJECTION
50
T3
SELECTION PREDICATE
PROJECTION
1000
=
JR2
SELECTION PREDICATE
PROJECTION
150

FIG. 6

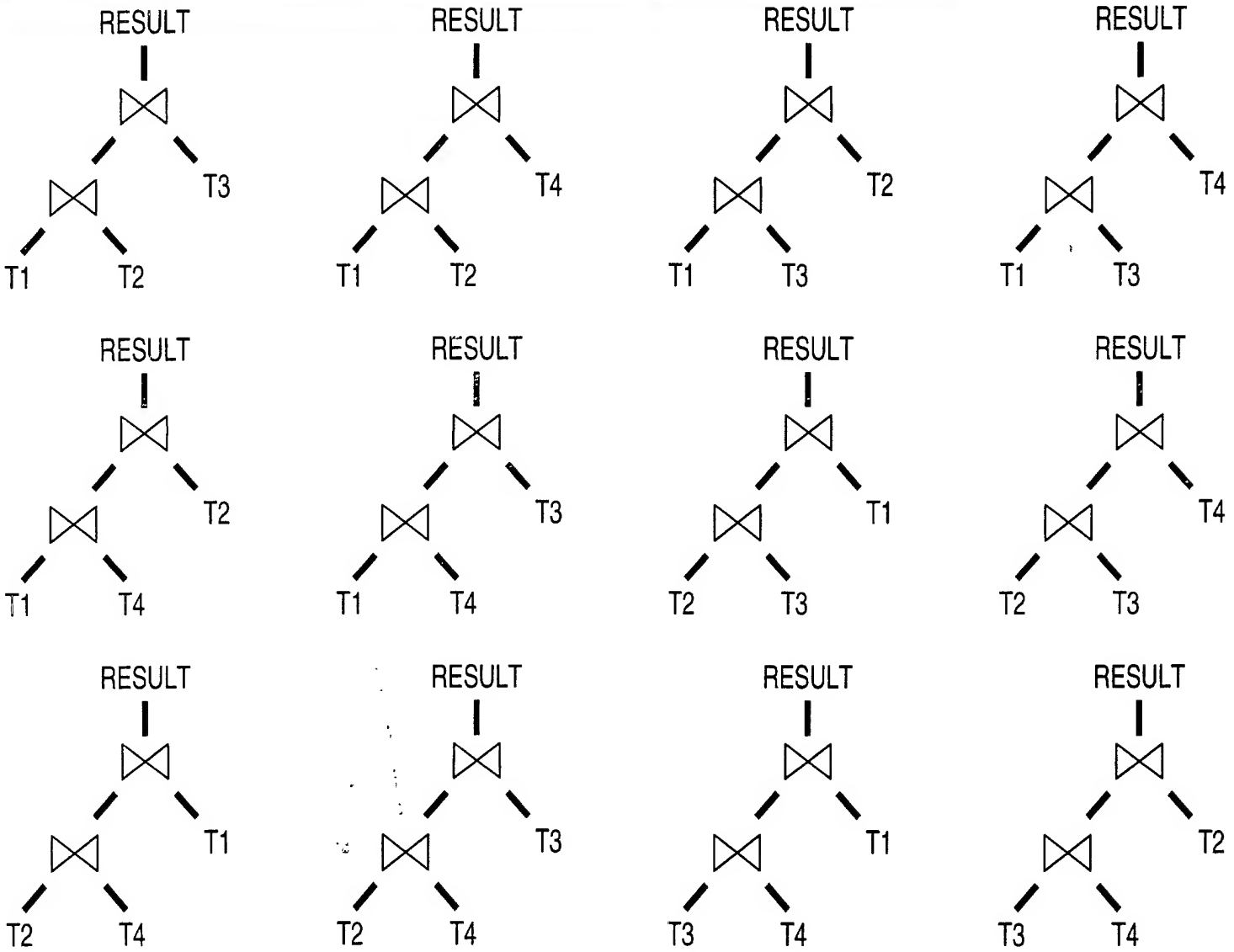

RESULT
T3
T1
T2
RESULT
T4
T1
T2
RESULT
T2
T1
T3
RESULT
T4
T1
T3
RESULT
T2
T1
T4
RESULT
T3
T1
T4
RESULT
T1
T2
T3
RESULT
T4
T2
T3
RESULT
T1
T2
T4
RESULT
T3
T2
T4
RESULT
T1
T3
T4
RESULT
T2
T3
T4

FIG. 7

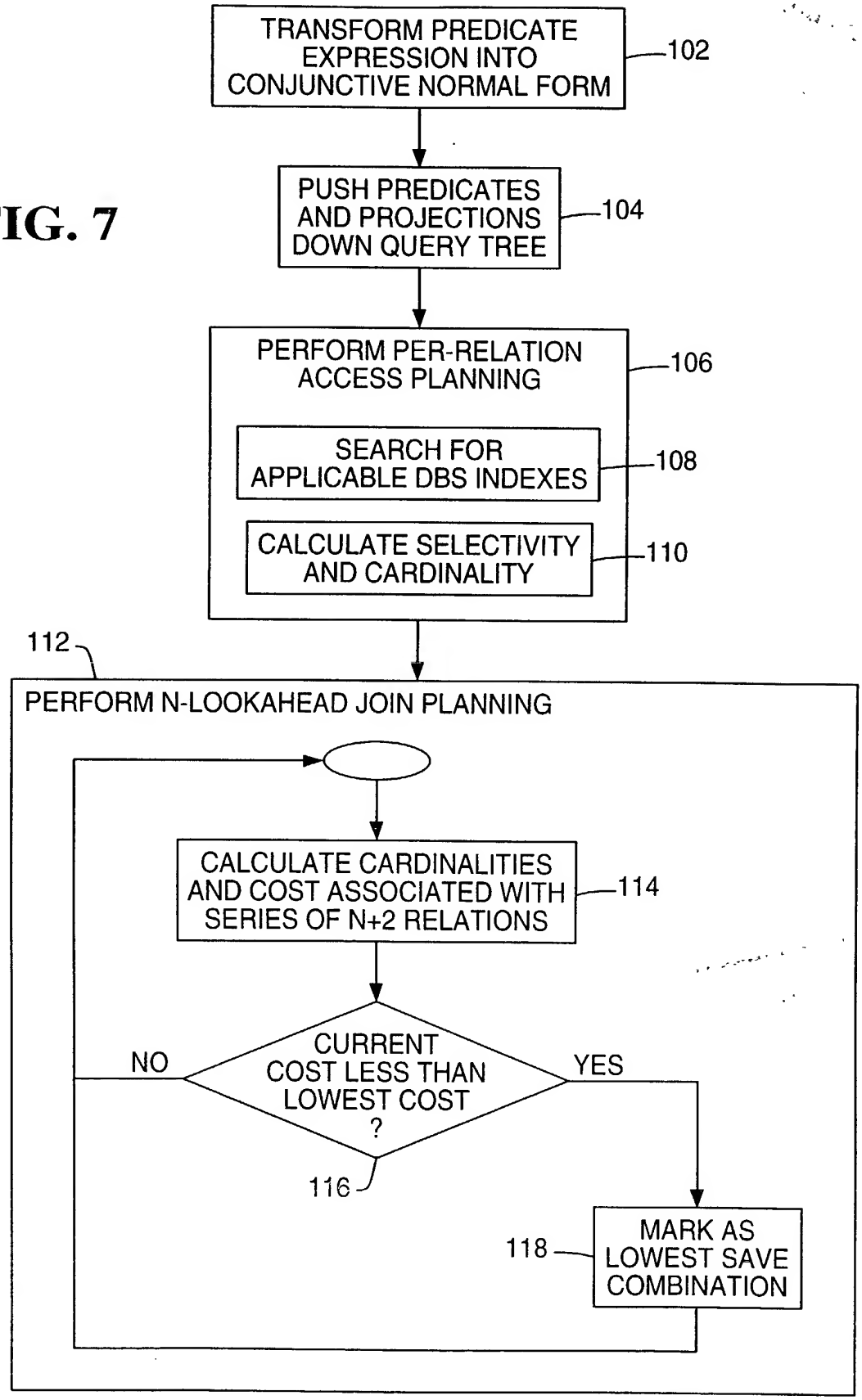

TRANSFORM PREDICATE EXPRESSION INTO CONJUNCTIVE NORMAL FORM
102
PUSH PREDICATES AND PROJECTIONS DOWN QUERY TREE
104
PERFORM PER-RELATION ACCESS PLANNING
106
SEARCH FOR APPLICABLE DBS INDEXES
108
CALCULATE SELECTIVITY AND CARDINALITY
110
112
PERFORM N-LOOKAHEAD JOIN PLANNING
CALCULATE CARDINALITIES AND COST ASSOCIATED WITH SERIES OF N+2 RELATIONS
114
CURRENT COST LESS THAN LOWEST COST ?
NO
YES
116
MARK AS LOWEST SAVE COMBINATION
118

FIG. 8

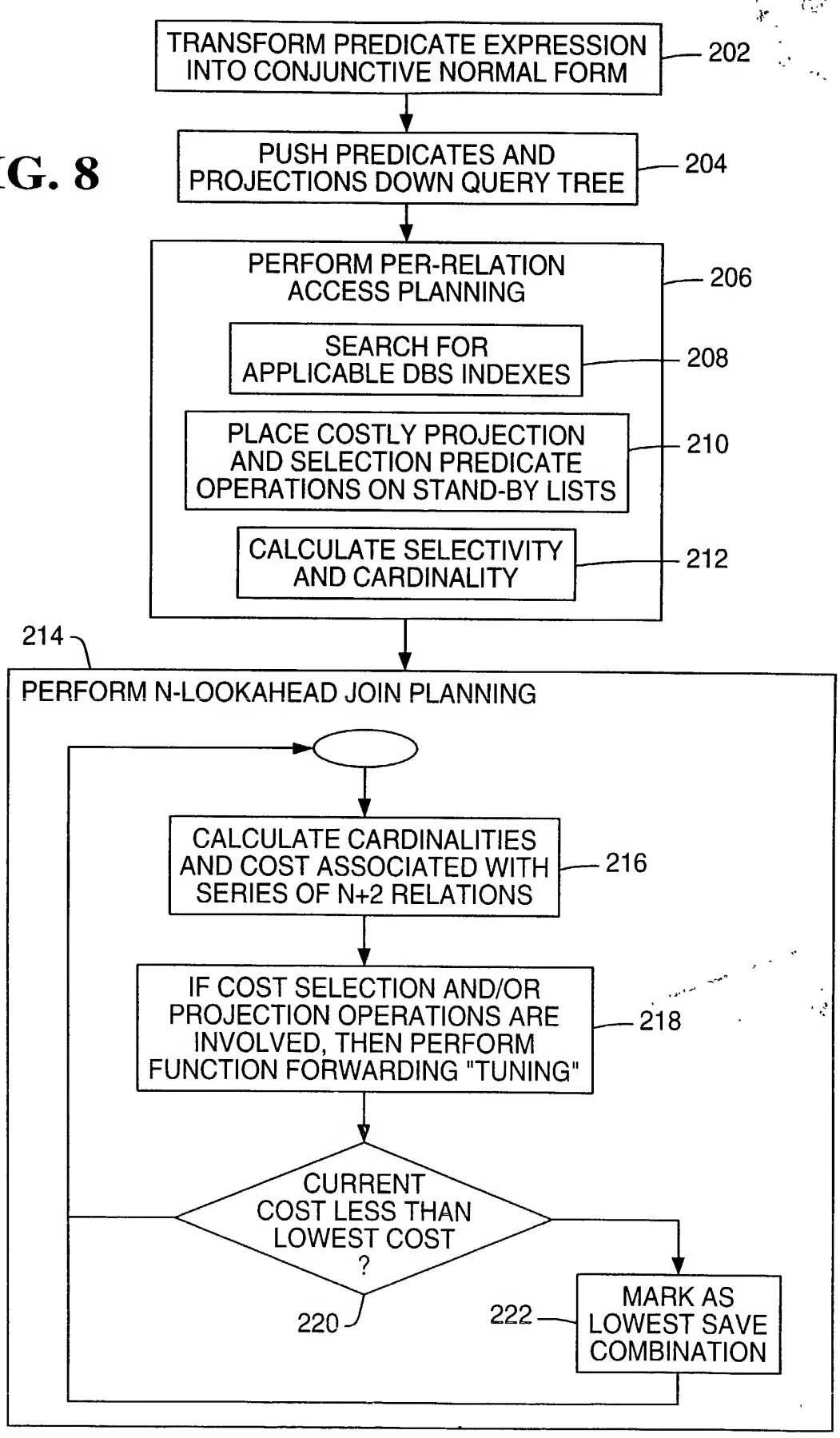
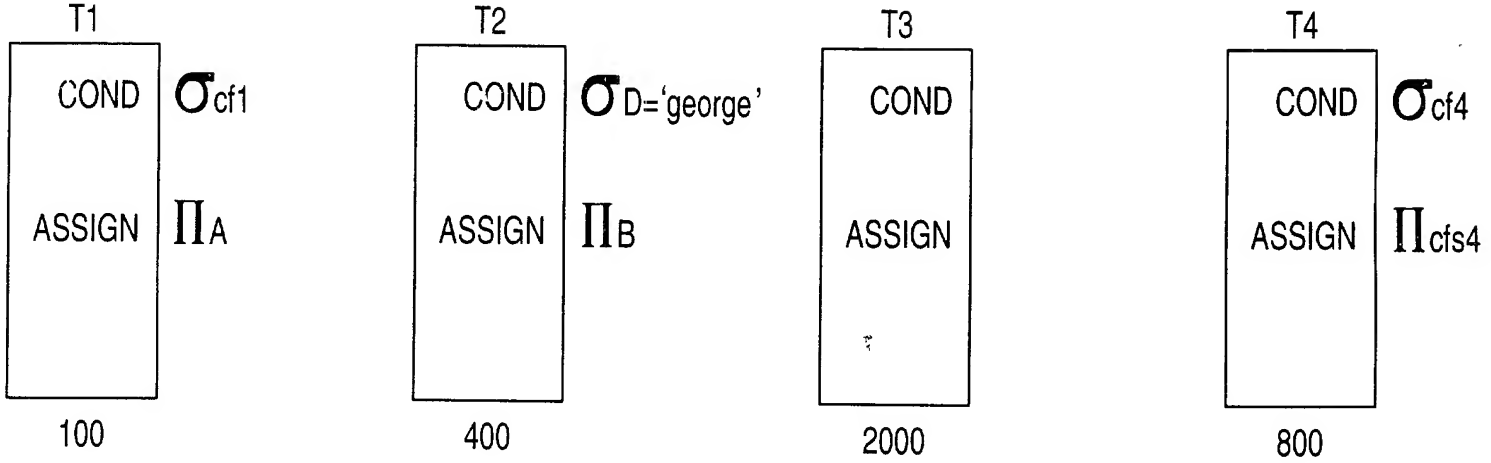

TRANSFORM PREDICATE EXPRESSION INTO CONJUNCTIVE NORMAL FORM
202
PUSH PREDICATES AND PROJECTIONS DOWN QUERY TREE
204
PERFORM PER-RELATION ACCESS PLANNING
206
SEARCH FOR APPLICABLE DBS INDEXES
208
PLACE COSTLY PROJECTION AND SELECTION PREDICATE OPERATIONS ON STAND-BY LISTS
210
CALCULATE SELECTIVITY AND CARDINALITY
212
214
PERFORM N-LOOKAHEAD JOIN PLANNING
CALCULATE CARDINALITIES AND COST ASSOCIATED WITH SERIES OF N+2 RELATIONS
216
IF COST SELECTION AND/OR PROJECTION OPERATIONS ARE INVOLVED, THEN PERFORM FUNCTION FORWARDING "TUNING"
218
CURRENT COST LESS THAN LOWEST COST ?
220
222
MARK AS LOWEST SAVE COMBINATION

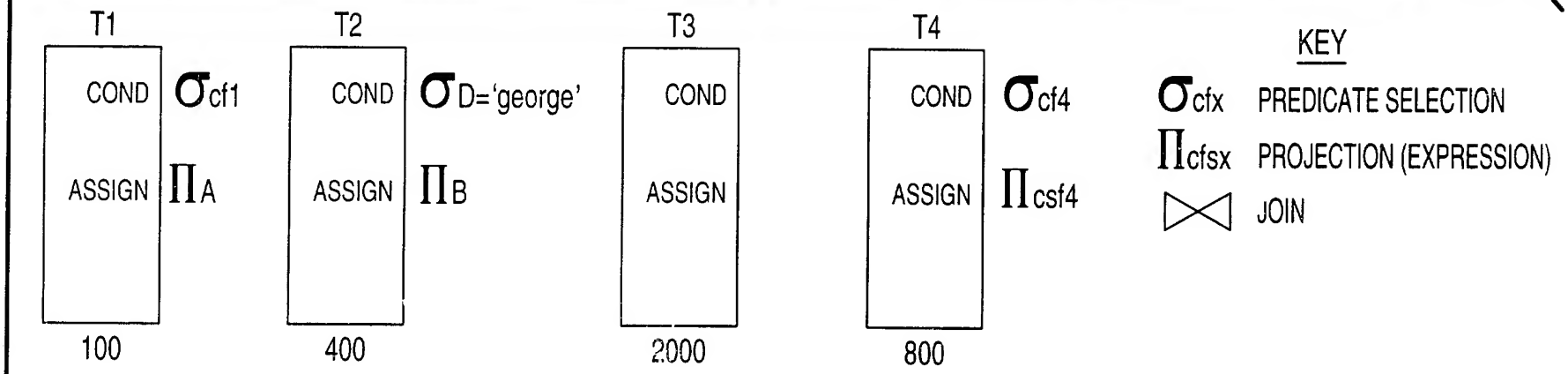
FIG. 10

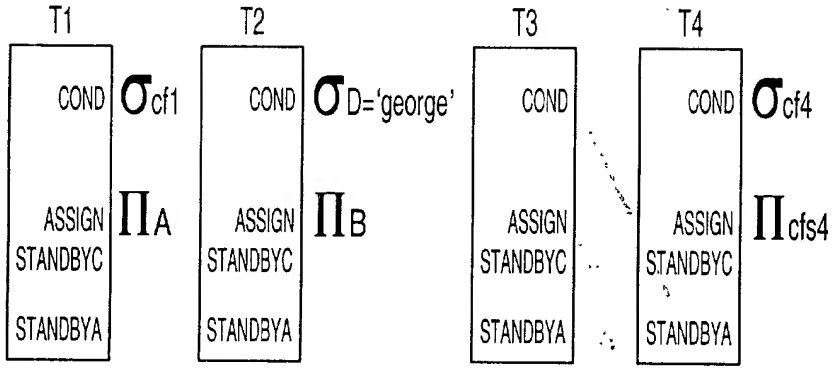
```
Select T1.A, T2.B, T4.Video Colorize() From T1, T2, T3, T4
    Where T1.face = IMAGE(\\url\myface.jpg) AND T2.D='george'
        AND T4.Audio = AUDIO (\\url\georgeharrison.wav)
            AND T1.F=T2.F AND T2.G=T3.G AND T1.H=T4.H
                AND T2.K=T4.K
```



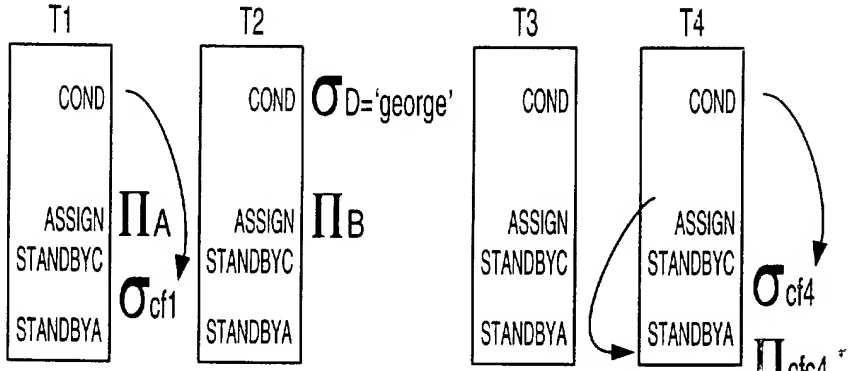
T1.face=IMAGE(\\url\myface.jpg)	σ_{cf1}
T4.Video.Colorize()	Π_{cfs4}
T4.Audio=AUDIO (\\url\georgeharrison.wav)	σ_{cf4}

FIG. 11





STEP 0 : START



(EARLY ON WITHIN ACCESS PLANNING MODULE)

STEP 1 : MOVE ALL COSTLY FUNCTIONS TO THEIR RESPECTIVE STANDBY LISTS

FIG. 12

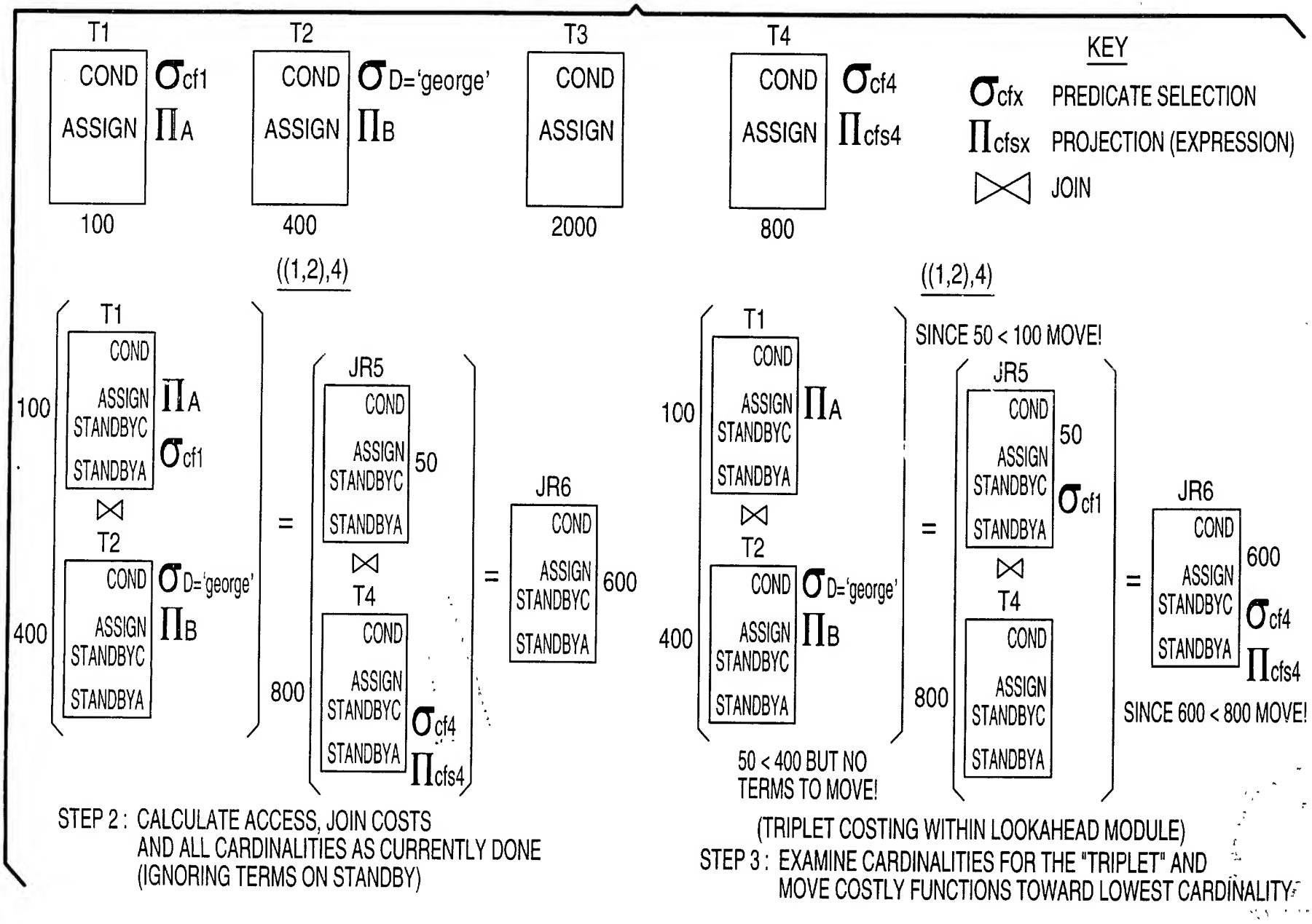
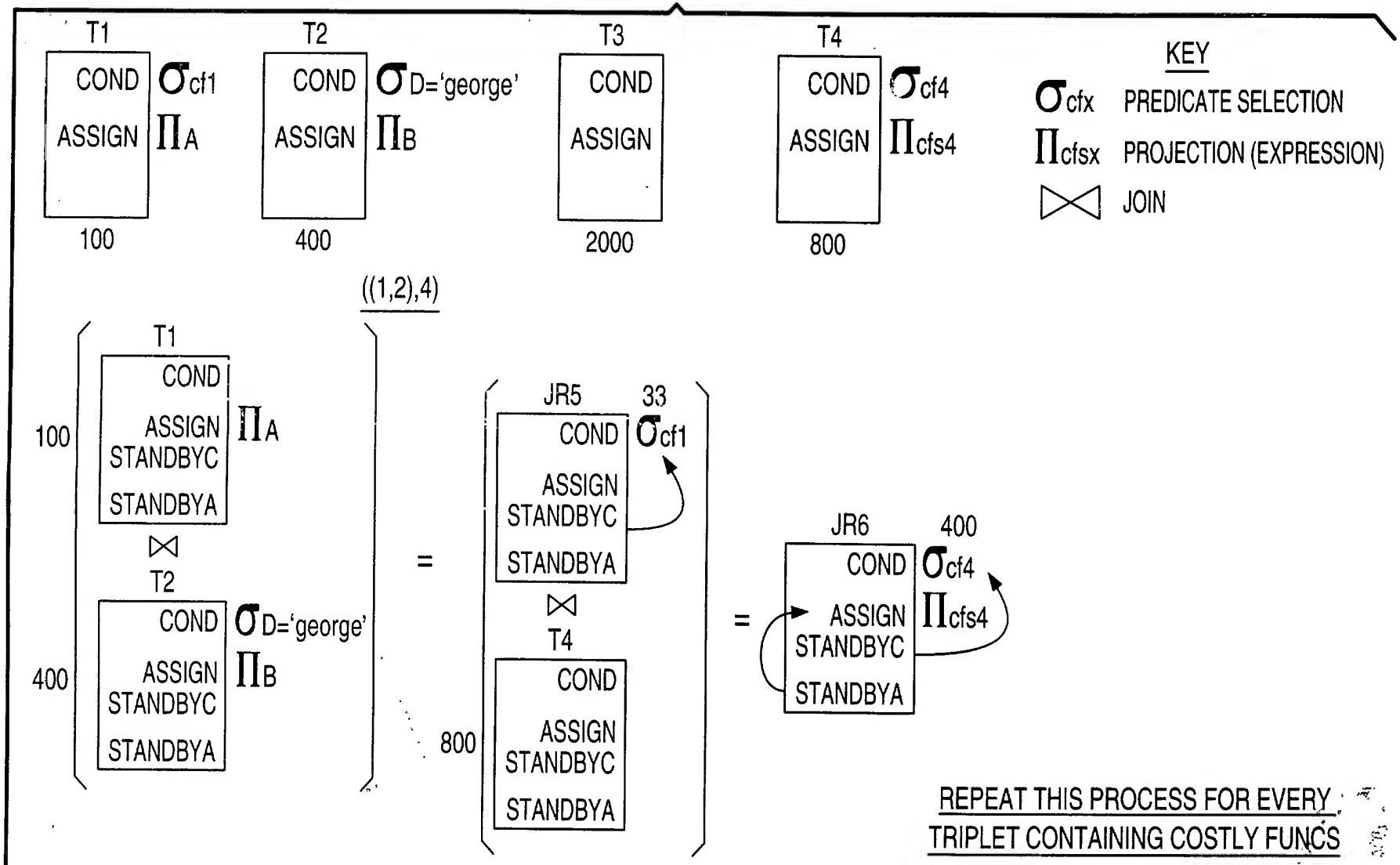

T1
COND
ASSIGN
σcf1
ΠA
100
T2
COND
ASSIGN
σD='george'
ΠB
400
T3
COND
ASSIGN
2000
T4
COND
ASSIGN
σcf4
Πcfs4
800
KEY
σcfx PREDICATE SELECTION
Πcfsx PROJECTION (EXPRESSION)
⋈ JOIN
((1,2),4)
100
400
800
STANDBYC
STANDBYA
JR5
JR6
50
600
=
STEP 2 : CALCULATE ACCESS, JOIN COSTS
AND ALL CARDINALITIES AS CURRENTLY DONE
(IGNORING TERMS ON STANDBY)
SINCE 50 < 100 MOVE!
50 < 400 BUT NO
TERMS TO MOVE!
SINCE 600 < 800 MOVE!
(TRIPLET COSTING WITHIN LOOKAHEAD MODULE)
STEP 3 : EXAMINE CARDINALITIES FOR THE "TRIPLET" AND
MOVE COSTLY FUNCTIONS TOWARD LOWEST CARDINALITY

FIG. 13


T1
COND
ASSIGN
σcf1
ΠA
100
T2
COND
ASSIGN
σD='george'
ΠB
400
T3
COND
ASSIGN
2000
T4
COND
ASSIGN
σcf4
Πcfs4
800
KEY
σcfx PREDICATE SELECTION
Πcfsx PROJECTION (EXPRESSION)
⋈ JOIN
((1,2),4)
T1
COND
ASSIGN
STANDBYC
STANDBYA
ΠA
100
⋈
T2
COND
ASSIGN
STANDBYC
STANDBYA
σD='george'
ΠB
400
=
JR5
33
COND
ASSIGN
STANDBYC
STANDBYA
σcf1
⋈
T4
COND
ASSIGN
STANDBYC
STANDBYA
800
=
JR6
400
COND
ASSIGN
STANDBYC
STANDBYA
σcf4
Πcfs4
REPEAT THIS PROCESS FOR EVERY TRIPLET CONTAINING COSTLY FUNCS
STEP 4 :MOVE TERMS FROM STANDBY LISTS TO ACTIVE LISTS AND CALCULATE NEW JOIN CARDINALITIES AND "TUNED" COST